The Model Underlying the Measurement of the Impacts of the IIC on the End-Users

Dale Goodhue
Department of Management, University of Georgia, Athens, GA 30602. E-mail: dgoodhue@cbacc.cba.uga.edu

This article describes the Task–Technology Fit model that provided the conceptual basis for the assessment of the impacts of the Integrated Information Center (IIC) on the end-users.

The Model

The purpose of this study was to determine the extent to which the Integrated Information Center (IIC), and the technologies and services which it provided, had a performance impact on faculty and students engaged in academic work. The center of focus is not the technologies, nor the organization, but the tasks of individuals in the target population, and the extent to which the technologies and the IIC supported those individuals at their tasks. The model which guided in this effort is the Technology-to-Performance model (Goodhue, 1992; Goodhue, 1995; Goodhue & Thompson, 1995), as shown in Figure 1.

The Technology-to-Performance Chain incorporates insights from two lines of research: One focuses on predicting the utilization of technologies, and the second focuses on the performance impacts of the fit between task requirements and technology characteristics. By combining these two perspectives, and recognizing that technologies must be utilized *and* fit the task they support before they can have a performance impact, the Technology-to-Performance Chain creates a more accurate picture of the way in which technologies, user tasks, and utilization combine to create changes in individual performance.

This new model is consistent with that proposed by Delone and McLean (1992) in that both utilization and user attitudes about the technology lead to individual performance impacts. It goes beyond the Delone and McLean model by being more explicit about the links between user attitudes, utilization, and performance, and by including the critical aspect of the technology fit to the task.

Figure 1 can best be understood as a formal recognition that for a technology to have a positive impact on performance, it must not only be utilized, but it must also be a satisfactory tool for the critical tasks at hand. As a counter example, Pentland (1989) found that IRS auditors had positive attitudes toward PCs and utilized them extensively, but that the PCs had little positive impact on their performance, or even negative impacts. According to Pentland, this may have been because PCs were utilized for inappropriate tasks, that is, tasks where the technology was not a good fit with task needs. If either the *task–technology fit* of the technology or its *utilization* is lacking, the technology will not improve performance.

Definition of Task–Technology Fit

''Task–Technology Fit'' is a key but overlooked construct in understanding the impact of technology on performance. ''Task–Technology Fit'' (TTF) is defined as the degree to which a technology (broadly defined to include information technologies, but also other manual technologies or techniques used to assist in task accomplishment) assists an individual in performing his or her portfolio of tasks. More specifically, it is the fit among task requirements, individual abilities, and the functionality and interface of the technology. Therefore, in addition to the question of how well the technology fits the task, there is also the question of how well the technology fits the abilities of the individuals engaged in the task, or individual–technology fit. It could be that ''task–individual–technology fit'' would be a more accurate label for the construct, but the less complex label is easier to use.

To the extent that we have a theory about what individual characteristics are required to complete a task with different types of technology, we could make some objective assessment of task–technology fit for a particular task, individual and technology. Task–technology fit is at least potentially an objective quantity. One could conduct an engineering analysis of task needs, individual skill levels, technology functionalities, and determine in some fashion the fit among all three. This would result in a fit

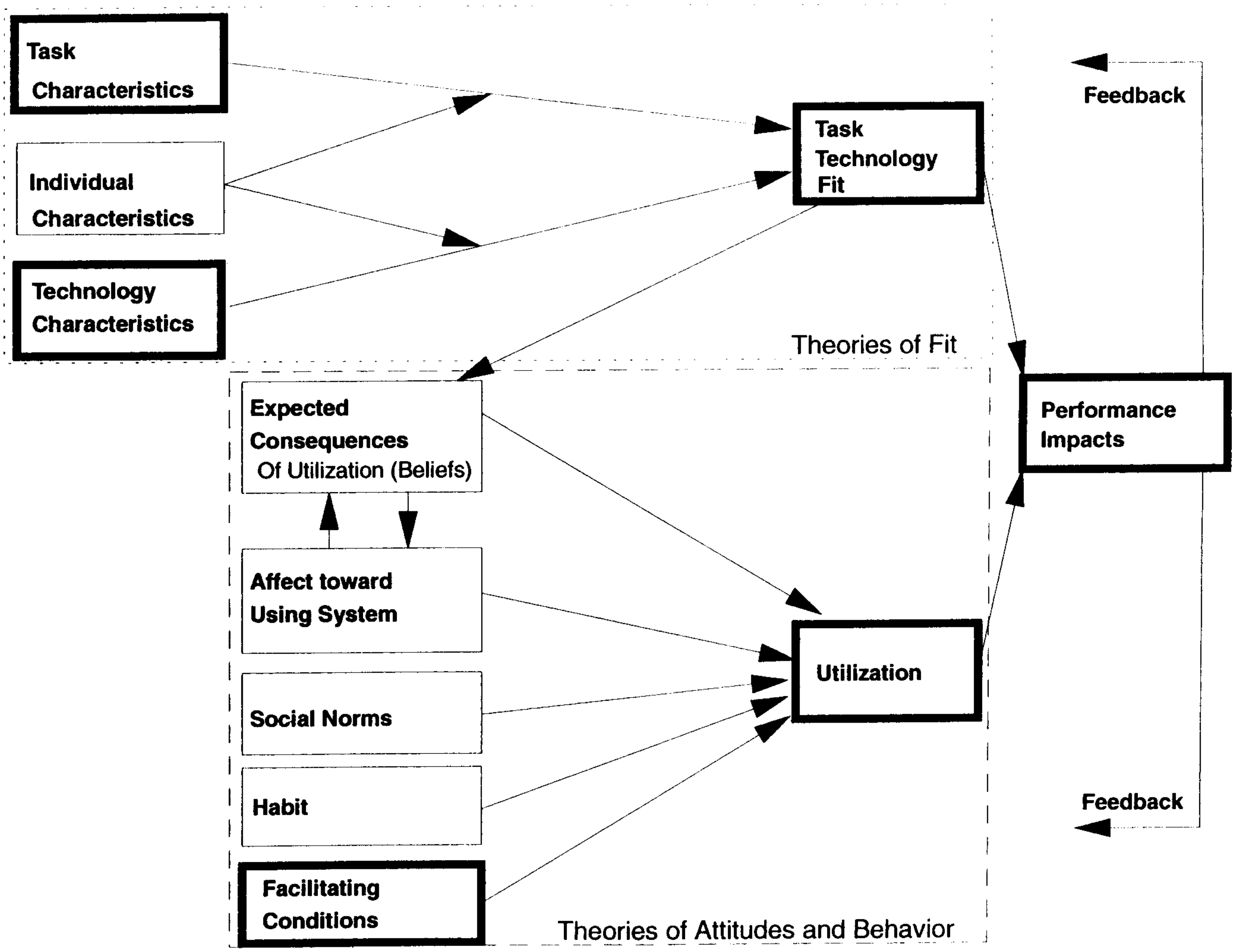

FIG. 1. The technology to performance chain.

measure that had some objective reality, independent of a user's perceptions.

Especially if we consider a portfolio of tasks, task–technology fit calculated in this way would be quite complex, as the average fit of a particular technology to the collection of tasks. However, this is not the only possible approach to assessing task–technology fit. A different and operationally simpler approach would be to ask users to express their beliefs about the extent of task–technology fit. That is the approach used in this evaluation.

Determinants of Task–Technology Fit

Figure 1 shows that task characteristics, individual characteristics, and technology all combine to lead to a task–technology fit (Goodhue, 1988). All other things being equal, changes to the technology environment (as in more appropriate functionality or policies) along the lines needed by the user for the tasks at hand should improve task–technology fit. Likewise, changes to tasks that result in the user making greater demands on the technology environment should decrease task–technology fit. It is easy to see that fit could be increased by improving the technology to better meet the task needs, or by redesigning or reengineering tasks to take better advantage of existing technology functionalities. It also might be improved by training users to take better advantage of the capabilities of the technology.

Utilization of Technologies

Figure 1 posits ''*utilization*'' as an intervening variable between technology characteristics and individual performance, or as Trice and Treacy (1988) suggest, as a necessary but not sufficient condition for technologies to result in improved performance. Utilization could be measured in a variety of ways: By the duration of utilization, the number of different functions utilized, the degree to which technology utilization is institutionalized, etc., each of which might be driven by slightly different conceptualizations of the construct (Trice & Treacy, 1988).

For the technology to performance model, at the most basic level of a single individual and a single task, utilization should be conceptualized as the choice to use or not to use the technology for that task (i.e., as a zero–one variable). This is consistent with the attitudes/behavior research underlying this portion of the model. When we expand the focus to consider a single individual engaged in a portfolio of tasks, utilization becomes the percentage of her portfolio of tasks for which an individual chooses to use the technology. The percentage of tasks for which the technology has been chosen is difficult to elicit from an individual, but we can get an approximation of it by asking whether the individual uses the technology a lot, a moderate amount, a little, or not at all, for example. Similarly, hours of use should correlate with this, since a person who uses a technology many hours uses it either for a great many tasks, or for a few tasks which occupy a large portion of that person's time.

When utilization is mandatory, then another measure might be the extent to which the use of the technology has become institutionalized. All of these are ways of determining the percentage of an individual's tasks for which she (or someone) has made the choice of utilizing the technology.

Determinants of Technology Utilization

Given the option to utilize a technology or not, a highly rational person might choose it for all those tasks where the value of the increment in performance was thought to be greater than the extra cost of utilizing it. Stated differently, a rational individual would utilize the technology for those tasks where she believed it to be a good fit to her abilities and task needs, and not for other tasks where it was not a good fit. This is consistent with the cognitive cost/benefit framework for the use of decision strategies suggested by Jarvenpaa (1989) and Todd and Benbasat (1991).

However, human behavior is not necessarily so rational. More generally, theories about attitudes and behavior can suggest the antecedents of utilization, since utilization is a behavior, and beliefs about costs and benefits of using a technology are attitudes. Much of the recent research on this topic has been based on Fishbein and Ajzen's (1975) theory of reasoned action or revisions to it (Ajzen, 1989; Chaiken & Stangor, 1987). For the technology to performance chain (specifically the lower boxed-in portion of Fig. 1), we utilized Bagozzi's (1982) model of attitudes and behavior, which though loosely based on Fishbein and Ajzen, is much more general, including both Fishbein and Ajzen's (1975) theory of reasoned action and Triandis (1979) theories of the relationship between attitudes and behavior as special cases.

Both Fishbein and Ajzen (1975) and Triandis (1979) link attitudes (beliefs and/or affect) with behavioral intentions and then to behavior. Both also suggest that social norms have an impact on behavioral intentions, and Triandis adds habit. Habit is potentially a very important factor, and a number of researchers have argued that past behavior has a robust direct influence on current behavior (e.g., Chaiken and Stangor, 1987; Ronis, Yates, & Kirscht, 1989). Bagozzi (1982) includes all these factors in his model.

These models all include ''behavioral intentions'' as an intervening construct between attitudes, beliefs, social norms, etc., on one hand, and behavior on the other. Fishbein and Ajzen (1976) claim that their theory of reasoned action predicts intentions, but that intentions do not necessarily predict behavior. Triandis (1979) suggests that external factors such as a lack of facilitating conditions may prevent individuals from taking intended actions. A number of psychologists have now focused on the question of when behavioral intentions do predict behavior (since they clearly do not always) and what other factors also predict behavior directly (see Chaiken and Stangor, 1987).

However, it appears that in the Information Technology (IT) domain, the link between beliefs/attitudes and behavior may be relatively strong, as born out by several recent IT studies (e.g., Davis, 1989; Davis, Bagozzi, & Warshaw, 1989; Hartwick & Barki, 1994; Moore & Benbasat, 1992; Thompson, Higgins, & Howell, 1991). It may be that where behavior is seen as instrumental for task completion (as it arguably is in the IT domain), the link between beliefs about outcomes and actual behavior may be stronger than in more typical psychological studies which tend to focus on less immediately instrumental behaviors, such as going on a diet, giving up smoking, approaching and handling a snake in a laboratory situation (Breckler, 1984), or giving blood in a blood drive (Bagozzi, 1981).

Further, in the IT realm, we are far more interested in predicting actual behavior, and performance impacts engendered by actual behavior than we are in predicting intentions. Stated differently, if we cannot predict utilization behavior directly from constructs that we might hope to affect by management action, there is questionable value in predicting intentions. For this reason, the lower boxed-in model in Figure 1 shows the key variables and relationships from Bagozzi's (1982) model, with intentions left out. This is consistent with the approach taken in Davis (1989), Thompson et al. (1991), and Moore and Benbasat (1992).

The Link between Task–Technology Fit and Utilization

Figure 1 shows a link between task–technology fit and beliefs about the consequences of using a technology. This is easily defended by looking at recent research to see what beliefs best predict utilization of information technologies. Davis (1989) found that beliefs about the ''usefulness'' of technologies strongly predicted utilization. Usefulness is in fact another way of saying that the technology provides the necessary functionality to perform the task at hand, or the technology has good task–technology fit. Moore and Benbasat (1992) found that among other things, ''relative advantage'' strongly predicted the use of personal work stations. The relative advantage of a particular technology is very closely associated with its fit to the task needs of the individual. Hartwick and Barki (1994) found that the degree to which users believed technologies to be important, needed, essential, relevant, etc., predicted their attitudes about utilizing them, and therefore their utilization. At least, to some extent, importance, relevance, and usefulness are highly dependent upon technologies fitting task needs, or task–technology fit.

These studies are consistent with the notion that where users perceived greater fit between their tasks and the functionality of the technology, they believed the technology would: 1) Be more useful to them, or 2) give them a greater relative advantage in accomplishing tasks more quickly, with greater quality, effectiveness, productivity, etc., or 3) be more important to them. Where technologies were perceived as being more useful, giving more relative advantage, or being more important, they were more likely to be utilized.

We do not show a direct link between task–technology fit and other potential determinants of utilization such as affect, social norms, or habit, because we believe that TTF operates primarily through changes in the expected consequences of use. According to our view, individuals will show higher affect toward using a technology when they believe use of the technology will result in desired consequences. Certainly affect (and the other determinants of utilization) is caused by many other factors as well, including personal characteristics such as previous pleasurable history with similar technologies, etc. We neglect these additional antecedents only as a way of bounding the focus of the model.

Performance

Performance in the model is the accomplishment of a task, or a portfolio of tasks, by an individual. To achieve higher levels of performance requires improved efficiency, improved effectiveness/quality, or some combination of both.

''Task–technology fit'' affects individual performance beyond its influence in promoting utilization. As shown in Figure 1, high task–technology fit will increase the likelihood of utilization, but it will also increase the performance impact of the technology when it is utilized. This is because greater task–technology fit means the technology more closely meets the task needs of the individual. To see this, note that because of social norms, habit, politics, etc., individuals will not always utilize technologies with the highest TTF. However, at any given level of utilization greater than zero, a technology with good TTF will give better performance than a technology with poor TTF.

Feedback

When a technology has been utilized and an individual is aware of certain performance effects, there will be several possible types of feedback. First of all, the actual experience of utilizing the technology will enhance the understanding of potential users about its task–technology fit, and therefore about the consequences of utilizing the technology. Users may decide that the technology has a better (or worse) impact on performance than anticipated, changing their expected consequences of utilization, and therefore affecting future utilization. An individual could also learn better ways of utilizing the technology, from the experience of using it. This would improve the fit between the individual and the technology, and hence the overall task–technology fit.

There is also the possibility of important managerial feedback effects at the organizational level. Based on an understanding of the performance impacts of a technology (and fit and utilization leading to that impact), managers may decide to: (1) Discontinue or redesign the technology, (2) embark on training or selection programs to increase the ability of users, or (3) redesign tasks so that work processes take better advantage of potential in the information technology (Goodhue, 1988). Thus the technology-to-performance chain provides a fundamental conceptual framework that is consistent with the issues faced in process redesign. This is important, since it is widely believed that redesigning tasks to harness the full potential of information technologies is the way to achieve dramatic performance impacts (Hammer, 1990).

Methods Employed for Impact Assessment

Two methods were employed for assessing the impacts of the IIC. The first method was a survey of the target population and a reasonable control group of faculty. The second method was a set of in-depth interviews of a smaller, carefully selected group of faculty. The advantages of multiple evaluation methods are that different sources of evidence provide different views and thus can lead to different insights in an approach called triangulation (Sackett & Larson, 1990; Yin, 1989). Any given method has advantages and disadvantages; the combination of complementary methods provides enormous opportunities for the researcher (Miles & Huberman, 1984; Sieber, 1973). The two methods chosen (wide-scope survey and selected in-depth interviews) allowed us to assess the impact of the IIC in very different ways, and each provided distinct opportunities for improving the understanding of what the impact of the IIC was and why.

In addition, both data collection efforts were carried out longitudinally—the first execution was before the IIC was operational and the second was after the IIC had been in operation for about 21 months. This allowed a before and after picture of the impacts of the IIC, making it possible to better track changes in the target population and their task processes. The design and results of the survey are reported in the following article by Goodhue, Littlefield, and Straub (1997), and the results of the interviews are reported in the subsequent article by Lending and Straub (1997).

References

Ajzen, I. (1989). Attitude structure and behavior. In: A. R. Pratkanis, S. Breckler, & A. G. Greenwald (Eds.), *Attitude and structure and function.* Hillsdale, NJ: Erlbaum.

Bagozzi, R. P. (1981). An examination of the validity of two models of attitude. *Multivariate Behavioral Research, 16,* 323–359.

Bagozzi, R. P. (1982). A field investigation of causal relations among cognitions, affect, intentions and behavior. *Journal of Marketing Research, 19,* 562–584.

Breckler, S. J. (1984). Empirical validation of affect, behavior, and cognition as distinct components of attitude. *Journal of Personality and Social Psychology, 47,* 1191–1205.

Chaiken, S., & Stangor, C. (1987). Attitude and attitude change. *Annual Review of Psychology, 38,* 575–630.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13,* 319–342.

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: A comparison of two theoretical models. *Management Science, 35,* 983–1003.

Delone, W. H., & McLean, E. R. (1992). Information systems success: The quest for the dependent variable. *Information Systems Research, 3,* 60–95.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention and behavior.* Reading, MA: Addison-Wesley.

Fishbein, M., & Ajzen, I. (1976). Misconceptions about the Fishbein model: Reflections on a study by Songer-Nocks. *Journal of Experimental Social Psychology, 12,* 579–584.

Goodhue, D. L. (1988, Fall). IS attitudes: Toward theoretical and definitional clarity. *Data Base,* pp. 6–15.

Goodhue, D. L. (1992). User evaluations of MIS success: What are we really measuring? *Proceedings of the Hawaii International Conference on Systems Sciences, IV,* 303–314.

Goodhue, D. L. (1995). Understanding user evaluations of information systems. *Management Science, 41,* 1827–1844.

Goodhue, D., Littlefield, R., & Straub, D. (1997). The measurement of the impacts of the IIC on the end-users: The survey. *Journal of the American Society for Information Science, 48,* 454–465.

Goodhue, D. L., & Thompson, R. L. (1995). Task-technology fit and individual performance. *MIS Quarterly, 19,* 213–236.

Hammer, M. (1990). Reengineering work: Don't automate, obliterate. *Harvard Business Review, 68,* 104–113.

Hartwick, J., & Barki, H. (1994). Explaining the role of user participation in information system use. *Management Science, 40,* 440–465.

Jarvenpaa, S. L. (1989). The effect of task demands and graphical format on information processing strategies. *Management Science, 35,* 285–303.

Lending, D., & Straub, D. (1997). Impacts of an integrated information center on faculty end-users: A qualitative assessment. *Journal of the American Society for Information Science, 48,* 466–471.

Miles, M. B., & Huberman, A. M. (1984). *Qualitative Data Analysis: A Sourcebook of New Methods,* Newbury Park, CA: Sage.

Moore, G. C., & Benbasat, I. (1992). *An empirical examination of a model of the factors affecting utilization of information technology by end users.* Working paper, University of British Columbia.

Pentland, B. T. (1989). Use and productivity in personal computers: An empirical test In: J. DeGross, J. Henderson, & B. Konsynski (Eds.), *Proceedings of the Tenth International Conference on Information Systems,* Boston, (pp. 211–222).

Ronis, D. L., Yates, J. F., & Kirscht, J. P. (1989). Attitudes, decisions, and habits as determinants of repeated behavior. In: A. R. Pratkanis, S. Breckler, & A. G. Greenwald (Eds.), *Attitude and structure and function.* Hillsdale, NJ: Erlbaum.

Sackett, P. R., & Larson, J. R., Jr. (1990). Research strategies and tactics in industrial and organizational psychology. In: M. D. Dunnette & L. Hough (Eds.), *Handbook of industrial and organizational psychology* (2nd ed.). Palo Alto, CA: Consulting Psychologists Press.

Sieber, S. D. (1973). The integration of fieldwork and survey methods. *American Journal of Sociology, 78,* 1335–1359.

Thompson, R. L., Higgins, C. H., & Howell, J. M. (1991). Towards a conceptual model of utilization. *MIS Quarterly, 15,* 125–143.

Todd, P., & Benbasat, I. (1991). An experimental investigation of the impact of computer based decision aids on decision making strategies. *Information Systems Research, 2,* 87–115.

Triandis, H. C. (1979). Values, attitudes, and interpersonal behavior. *Nebraska Symposium on Motivation.* Lincoln, NE: University of Nebraska Press.

Trice, A. W., & Treacy, M. E. (1988). Utilization as a dependent variable in MIS research. *Data Base, 19,* 33–41.

Yin, R. K. (1989). *Case study research: Design and methods* (Rev. ed.). Newbury Park, CA: Sage.